RESEARCH SUMMARY 36 JULY 1969

Fruit Crops Research -- 1969

PART II. TREE FRUITS

OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER
Wooster, Ohio

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FRUIT CROPS RESEARCH NOTES

Apple Scald Inhibitors

In some OARDC research trials during the past season, a considerable amount of scald was experienced on fruits of Starking, Rome Beauty, and Stayman Winesap, even on highly colored fruits. None of these fruits had been treated with scald-inhibiting chemicals prior to storage due to the nature of the studies involved. This again emphasizes the importance of using scald inhibitors on apples intended for long-time storage, even though the fruits have a larger percentage of red surface color.

D. W. Kretchman
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Apple Snack Item

A new fruit processing project at the Research Center involves the development of a new apple product, with emphasis applied to a snack item. The development of such a product, having high consumer acceptance, would not compete with existing apple products (cider, slices, sauce, etc.) and would increase the demand for apples. This study will utilize the inherent properties of apples in an effort to create a nutritious, high quality convenience food item for the apple industry.

James F. Gallander
Department of Horticulture

Peach Cultivars for Processing

During the 1969 peach season, a study will be made to ascertain the suitability of several peach cultivars for processing (freezing and canning). These findings will provide information to growers, processors, and consumers as to those cultivars which, when grown under Ohio conditions, will produce the highest quality processed product.

James F. Gallander
Department of Horticulture

Stem Pitting of Peach in Ohio--1969

Last year, stem pitting of peach was reported to have occurred in one Ohio orchard (Fruit Crops Research--1968. Part II--Tree Fruits. Research Summary 27, pp. 1-4). This disease has now been observed in a total of four plantings at three widely separated locations. Trees affected by stem pitting decline and eventually die. Diseased trees apparently do not recover. There is evidence in Ohio and other states that the disease may spread within an orchard and from orchard to orchard. If stem pitting should become established in Ohio, its effect on the state's peach industry could be devastating.

An extensive survey of Ohio orchards is currently underway in an effort to determine exactly how prevalent stem pitting is in the state. This survey is a cooperative effort of the OARDC, the Cooperative Extension Service, and the Division of Plant Industry of the Ohio Department of Agriculture. For a more complete report on the current status of stem pitting in Ohio, the reader may consult the article, New Peach Disease in Ohio Orchards, in Ohio Report, 54(1):11-13, January-February 1969.

Brian M. Jones
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Breeding Pears for Fireblight Resistance

The cooperative pear breeding program between OARDC and USDA is now in its fourth year. The principal objective is the development of new high quality pear cultivars which are resistant to the fireblight disease. Crosses have been made each spring between cultivars or selections with a high degree of field resistance to fireblight and with special emphasis on dessert quality, fine texture, good appearance, and absence of grit and russet. About 1200 seedlings from these crosses have been planted each fall since 1966 and nearly 5000 should be under observation by the end of 1969.

William A. Oitto
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TOTAL YIELD AND TREE CIRCUMFERENCE OF 31 APPLE CULTIVARS ON THEIR OWN AND ON HIBERNAL FRAMEWORK, 1948-1968

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Total yield per tree is a major factor in the profitability of an apple cultivar providing it has market acceptability. In addition to yield, the resistance of a cultivar to low temperature injury during the period from mid-November through March has been of some concern in the past, particularly following winters in which the air temperatures have fallen rapidly to -10° or -20° F. It is known that certain cultivar groups such as those of Delicious and Stayman Winesap are in the class of those relatively susceptible to such injury. Hibernal has been utilized to a very limited extent over the years as a cultivar not only very resistant to cold but also one which possesses wide-angled primary scaffolds.

During the 1948-49 period, 31 cultivars were planted. Three trees of each were budded or grafted on Hibernal framework and three trees of each were propagated only by budding on apple seedlings. In the latter cases, the trunk and framework of the primary scaffold branches consisted of the cultivar involved.

During the 21-year period, all trees have been grown in sod to which a nitrogen carrying fertilizer has been applied annually. No flower or fruit thinning chemicals have been used in concentrations which resulted in reduction of the yield per tree below that considered to be a "full" commercial crop.

Throughout the period, the yield per tree and trunk circumference has been recorded. The total accumulative yield per tree and trunk circumferences at the end of the period were utilized in calculating the results presented in Tables 1 to 3.

Table 1 presents the total accumulative yield of the 31 cultivars on the two frameworks. The cultivars on their own trunks are ranked in descending order of yield. As can be noted, the order on Hibernal was different in a number of instances. Some cultivars showed a higher accumulative yield propagated on their own trunks than on Hibernal, while the reverse was true in other cultivars.

Based on total yield on their own framework, the 10 highest yielding cultivars in descending order were Melrose, Red McIntosh, McIntosh, Turley, Stayman, Staymared, Cortland, Rome Beauty, Jonathan, and Starking. The difference between the two McIntosh cultivars was not significant and the same lack of significance was evident in the Stayman Winesap group. Starking produced an intermediate yield. Lodi and Yellow Transparent were relatively poor producers. The unimportant cultivars such as Mother, Wealthy, and Canada Red were at the bottom of the list.

On Hibernal, the 10 highest yielding cultivars in descending order were McIntosh, Turley, Franklin, Summer Rambo, Stayman, Melrose, Rome

Beauty, Ruby, and Gallia Beauty. It should be noted that Starking outyielded Richared on both frameworks. Starking ranked 10th and 11th on its own framework and on Hibernal, respectively.

Table 2 presents the trunk circumferences of the trees of the 31 cultivars on the two frameworks. On their own framework and in descending order, Red McIntosh, Melrose, and McIntosh produced the largest trees, with no significant difference between them. The next group

TABLE 1.--Total Accumulative Yield of 31 Apple Cultivars on Their Own and Hibernal Framework, Orchard A, 1948-1968.

Cultivar	Total Accumulative Yield (lb.) Own Framework	Hibernal
Melrose	12,188	9652
Red McIntosh	10,861	8831
McIntosh	10,079	10,950
Cortland	9955	8917
Turley	9895	10,910
Stayman	9663	9819
Staymared	9560	7756
Rome Beauty	8850	9483
Jonathan	8751	6329
Starking	8460	8843
Franklin	8138	10,309
Golden Delicious	7988	6605
Gallia Beauty	7633	8891
Scarlet Staymared	7613	8290
Baldwin	7335	6463
Ruby	7294	9262
Richared	7071	7569
Blaxtayman	7011	8817
Macoun	6781	8213
Summer Rambo	6768	9880
Northern Spy	6651	6855
Jon-A-Red	6522	6509
Grimes Golden	6077	8061
Melba	5645	4716
Maiden Blush	5179	5890
Lodi	5082	4174
Rhode Island Greening	5042	5601
Yellow Transparent	4441	3878
Mother	3444	4608
Wealthy	3128	2824
Canada Red	2441	6122

included Rhode Island Greening, Summer Rambo, Cortland, Baldwin, Starking, and Stayman. The differences in tree growth as measured by trunk circumference were relatively small. Franklin, Gallia Beauty, Golden Delicious, and Ruby produced somewhat smaller trees. Mother, Wealthy, and Canada Red were at the bottom of the entire list of cultivars with respect to trunk circumference. On Hibernal, in descending order the largest trees were Franklin, Red McIntosh, McIntosh, Cortland, Summer Rambo, Maiden Blush, Macoun, Northern Spy, Stayman, Grimes

TABLE 2.--Trunk Circumference of 31 Apple Cultivars on Their Own and Hibernal Frameworks, Orchard A, 1948-1968.

Cultivar	Circumference of Trunk (inches)	
	Own Framework	Hibernal
Red McIntosh	50.9	46.6
Melrose	50.8	40.8
McIntosh	50.5	45.8
Rhode Island Greening	48.9	39.7
Summer Rambo	48.5	45.3
Cortland	47.0	45.6
Baldwin	46.7	38.4
Starking	46.0	39.0
Stayman	45.9	39.2
Macoun	45.1	42.3
Melba	44.8	37.5
Turley	44.7	40.9
Jonathan	44.6	36.7
Staymared	44.3	34.8
Northern Spy	44.3	43.0
Maiden Blush	43.9	42.3
Yellow Transparent	42.9	34.5
Rome Beauty	42.4	35.7
Lodi	42.4	37.4
Blaxtayman	42.2	35.6
Jon-A-Red	41.9	40.4
Richared	41.9	38.0
Scarlet Staymared	40.3	36.2
Franklin	39.8	49.1
Gallia Beauty	38.9	34.8
Golden Delicious	37.5	33.3
Grimes Golden	37.0	40.4
Ruby	36.9	36.1
Mother	32.6	33.8
Wealthy	29.5	31.5
Canada Red	23.6	38.9

Golden, and Jon-A-Red. Their order differed appreciably from that observed when these cultivars were propagated on their own trunk.

In view of the wide differences in size and yield of trees of the various cultivars, the data in Table 3 presenting the yield in pounds to 1 inch of trunk circumference are important. Melrose surpassed all cultivars in this respect, followed by Turley, Staymared, Red McIntosh, Golden Delicious, Cortland, Stayman, Blaxtayman, Rome Beauty, and Franklin. A third group comprised of McIntosh, Ruby, Gallia Beauty,

TABLE 3.--Total Number of Pounds of Fruit Produced to 1 Inch of Tree Circumference by 31 Cultivars on Their Own and Hibernal Frameworks, Orchard A, 1948-1968.

Cultivar	Pounds of Fruit to 1 Inch of Circumference	
	Own Trunk	Hibernal
Melrose	240	237
Turley	222	267
Staymared	216	253
Red McIntosh	213	189
Golden Delicious	213	198
Cortland	212	196
Stayman	210	250
Blaxtayman	209	197
Rome Beauty	209	266
Franklin	204	210
McIntosh	199	239
Ruby	198	256
Gallia Beauty	196	258
Jonathan	196	172
Scarlet Staymared	189	229
Starking	184	227
Grimes Golden	165	199
Richared	164	200
Baldwin	157	108
Jon-A-Red	156	161
Macoun	150	196
Northern Spy	150	162
Summer Rambo	140	218
Melba	126	126
Lodi	120	109
Maiden Blush	118	139
Wealthy	106	90
Mother	106	136
Yellow Transparent	104	111
Canada Red	104	157
Rhode Island Greening	103	142

Jonathan, Scarlet Staymared, and Starking followed with somewhat lower yields. As expected, Lodi and Yellow Transparent were low in terms of yield to 1 inch of trunk circumference.

On Hibernal, the 10 most productive cultivars in descending order were Turley, Rome Beauty, Gallia Beauty, Ruby, Staymared, Stayman, McIntosh, Melrose, Scarlet Staymared, and Starking. The differences between several of these cultivars were not significant. Summer Rambo and Franklin followed in yield to 1 inch of trunk circumference. It should be noted that Red McIntosh, Golden Delicious, Cortland, and Richared were still lower in terms of yield to 1 inch of trunk circumference. Lodi, Yellow Transparent, and Wealthy produced the poorest yields of any cultivar grown.

In general, the results utilizing the various cultivars on their own trunks (with no intermediate framework) were more satisfactory. Those cultivars of major importance in Ohio were at the top of the list in terms of total yield to 1 inch of trunk circumference. The only exceptions were Melba, Lodi, and Yellow Transparent.

Certain cultivars such as Gallia Beauty, Rome Beauty, and Ruby produced much higher yields to 1 inch of circumference on Hibernal than on their own frameworks. Melrose produced about the same yield to 1 inch of trunk circumference on Hibernal as on its own trunk but its rank on Hibernal was somewhat lower due to the higher yields of Rome Beauty, Gallia Beauty, Ruby, Staymared, and Stayman on Hibernal.

Richared and Starking produced similar yields to 1 inch of trunk circumference but production of both cultivars was higher on Hibernal. In both instances, the yields were moderate. Golden Delicious was a high producer on its own trunk but less on Hibernal.

In view of the fact that no really severe low temperature injury occurred during this 21-year period, no particular advantage of Hibernal was evident. The widths of the primary scaffold crotches were superior on Hibernal. Hibernal has been superior only with the naturally very very narrow angled cultivars such as Ruby.

Comparative tests of various hardy intermediate stocks at the Mahoning County Branch and at Horticultural Research Unit No. 2 at Wooster have shown that Kulon Kitaika and Columbia Crab are equal if not superior to Hibernal as an intermediate framework. Unfortunately, these two cultivars are not generally available. Hardy intermediate framework probably should be used only with the cultivars of the Delicious and Stayman Winesap groups.

Generally, it appears that the best results are obtained with the cultivars on their own frameworks except in those cases where the hazard of low temperature injury is considered severe. Under such conditions, selection of Columbia Crab which can be obtained from at least one nursery might well be utilized.

Fruit Crops Research--1969. Part II. Tree Fruits. Research Summary 36, Ohio Agricultural Research and Development Center, Wooster, Ohio. July 1969.

Orchard A, Horticultural Unit No. 1, Ohio Agricultural Research and Development Center, Wooster, 1968.

ACCUMULATIVE YIELD, TREE CIRCUMFERENCE, AND RELATION OF YIELD TO TREE SIZE OF RICHARED AND RUBY ON 13 INTERMEDIATE STOCKS, 1955-1968

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In view of the hazard of low temperature injury to trunks and primary scaffolds of various apple cultivars, an orchard planting comprised of Richared and Ruby propagated on 13 intermediate stocks was established in 1955 at Horticultural Research Unit No. 2 of the Ohio Agricultural Research and Development Center.

The trees of each cultivar were planted at random in connection with another planting of six cultivars propagated on semi-dwarfing Malling VII. The intermediate stocks, with the exception of Ruby and Richared, had been obtained from Canada and indirectly from the Soviet Union.

The two cultivars were topworked on the primary scaffolds of the 13 intermediate stocks during the period from 1955 to 1958. Only four primary scaffolds were usually budded to either Richared or Ruby. Richared and Ruby scions propagated on apple seedlings with no topworking on their own framework were used as controls.

In addition to total accumulative yield and tree circumference, the relationship between these two indices of tree growth and production provides valuable information. By this means it becomes possible to ascertain whether a lower total yield is due to a smaller tree size, failure of flowers to develop annually, or insufficient amounts of flowers to produce full crops. Under such circumstances, trees of the smaller cultivars obviously should be established at a greater density or more trees per acre than large trees of another cultivar with an equal yield/circumference ratio.

The data for Richared and Ruby for the period since propagation up to and including 1968 are presented in Tables 1 and 2.

Table 1 presents the data for Richared. With respect to total accumulative yield, trees on Harbin Selection 16109 as well as those propagated on apple seedlings produced the largest quantities. On the other hand, Richared and Chinese Shampanren were incompatible. On the basis of pounds of fruit to 1 inch of circumference, trees on Byshe Hardy Crab were superior to all other combinations. Richared itself (apple seedling) was only moderate in yield, indicating its delay in bearing. A similar situation existed with Richared budded on itself. Possibly one of the most interesting facts to be noted is the higher yield per inch of circumference produced by Byshe Hardy Crab trees which were relatively small. Hibernal was intermediate in both trunk circumference and yield.

Table 2 presents the same relationships between yield and tree circumference for Ruby. Kulon Kitaika produced the largest tree and second largest relationship between yield and tree circumference.

TABLE 1.--Accumulative Yield, Tree Circumference and Relation of Yield to Tree Size of Richared on 13 Intermediate Stocks, 1955-1968.

Intermediate Stock	Accumulative Yield (lb.)	Trunk Circumference (inches)	Pounds of Fruit to 1 Inch of Trunk Circumference
Harbin Selection 16109	1702	26.77	63.6
Apple Seedling (rootstock)	1647	28.78	57.2
Byshe Hardy Crab	1560	20.80	75.0
Malus robusta No. 5	1558	22.92	69.8
Kulon Kitaika	1480	24.59	60.2
Antonovka Zheltaia	1382	22.79	60.6
Columbia	1369	23.61	58.0
Hibernal	1288	23.26	55.4
Richared	1259	26.17	47.2
Bellflower Kitaika	1175	22.12	53.1
N. Queen x C. Pippin	1118	19.81	58.3
Mecca x Dolgo	1031	21.56	47.8
Chinese Shampanren	419	13.94	30.0

Ruby budded on its own trunk produced a low yield per inch of circumference. As with Richared, Ruby on Byshe Hardy Crab produced the largest yield for 1 inch of trunk circumference. Chinese Shampanren showed a pronounced incompatibility with Ruby. Hibernal produced an intermediate size tree and yield. The same was true for Columbia.

In comparing the total accumulative yield of the two cultivars over the period from budding, Ruby produced 36 percent more fruits than Richared. Undoubtedly this difference was due to the longer time required for Richared to come into bearing, its greater susceptibility to frost injury during bloom, and the early heavy bearing characteristics of Ruby.

In general it is evident with Richared that Kulon Kitaika and Harbin Selection 16109 produced large trees with comparable large yields. Kulon Kitaika produced similar results with Ruby. For a

TABLE 2.--Accumulative Yield, Tree Circumference and Relation of Yield to Tree Size of Ruby on 13 Intermediate Stocks, 1955-1968.

Intermediate Stock	Accumulative Yield (lb.)	Trunk Circumference (inches)	Pounds of Fruit to 1 Inch of Trunk Circumference
Kulon Kitaika	2364	24.49	96.6
Mecca x Dolgo	2106	23.07	91.3
Harbin Selection #16109	1976	24.90	79.3
Malus robusta No. 5	1963	21.32	92.1
Antonovka Zheltaia	1956	21.64	90.4
Apple Seedling (rootstock)	1922	23.14	83.1
Hibernal	1888	21.37	88.4
Byshe Hardy Crab	1833	18.54	99.0
Columbia	1769	21.49	83.6
Bellflower Kitaika	1576	21.62	72.9
Ruby	1477	21.93	67.4
N. Queen x C. Pippin	1292	18.26	77.5
Chinese Shampanren	1080	17.00	63.5

smaller tree with a high yield, Byshe Hardy Crab was very satisfactory with both cultivars. The principal value of Hibernal was its wide crotches as its yield was not outstanding. Columbia Crab produced a relatively small tree with a comparable yield.

Ruby naturally has very narrow crotches formed by the primary scaffold branches. Several of these intermediate stocks were superior in this respect.

Fruit Crops Research--1969. Part II. Tree Fruits. Research Summary 36, Ohio Agricultural Research and Development Center, Wooster, Ohio. July 1969.

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RATIO OF GROWTH TO YIELD OF SIX APPLE CULTIVARS ON MALLING VII, 1955-1968

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Yield differences between trees of various cultivars on semi-dwarfing stocks have been observed since the introduction of these stocks many years ago. The reasons for these differences are varied. Among them is the tendency for some cultivars to bear alternately or to come into bearing earlier. Certain ones may have an inherited tendency to bear less heavily or to be more susceptible to frost injury during the flowering period. Any one of these may account for differences between yields, in addition to a possible delayed incompatibility between stocks and a particular scion variety or cultivar.

In the semi-dwarf stock experiment at Horticultural Research Unit No. 2 of the Ohio Agricultural Research and Development Center, six cultivars were established on Malling VII in 1955. Reports on the accumulative yield of each cultivar on Malling VII have been presented in previous Research Summaries. However, the accumulative yield in terms of amount to an inch of tree circumference has never been presented. Trunk circumference is one of the few means of measuring tree size and this method of relating accumulative yield to tree circumference is important in explaining differences in cultivar yield during a given period. The results present some interesting information between the six cultivars and explain in part the differences in accumulative yield obtained over the 13-year period.

Table 1 presents the accumulative yield during this period in bushels, trunk circumference at the conclusion of 1968 in inches, and

TABLE 1.--Average Tree Circumference, Accumulative Yield per Cultivar, and Relation of Circumference to Yield in Six Cultivars on Malling VII, 1955-1968.

Cultivar	Average Tree Circumference (inches)	Accumulative Yield per Tree (bushels)	Pounds of Fruit per 1 Inch of Trunk Circumference
Melrose	22.55	118.5	2519
Ruby	19.75	98.5	2394
Gallia Beauty	18.83	97.6	2486
Blaxtayman No. 201	22.23	96.2	2077
Golden Delicious	21.10	96.0	2181
Starking	22.78	90.1	1898

Fig. 1.--Typical example of Melrose on Malling VII on semi-dwarfing rootstock, 1968.

Fig. 2.--Typical example of Blaxtayman on Malling VII on semi-dwarfing rootstock, 1968.

pounds of fruit per inch of trunk circumference. Melrose, Blaxtayman No. 201, and Starking produced trees not appreciably different in size, although the accumulative yield of Melrose was much greater. On the other hand, although the size of the Ruby and Gallia Beauty trees was much smaller than Melrose, the average number of pounds of fruit to 1 inch of tree circumference was not much less. Blaxtayman was as large as Melrose but the yield per inch of tree circumference was much less. Golden Delicious produced a moderately sized tree but its yield per inch of circumference was somewhat greater than Blaxtayman No. 201 and appreciably larger than that of Starking.

Examination of the annual yields of the various cultivars emphasizes the following points:

1. Melrose usually bore large yields of fruit annually.

2. Starking was later in coming into bearing and the flowers were more susceptible to low temperature injury.

3. Golden Delicious gradually developed a tendency to alternate bearing.

4. Blaxtayman, similarly to Delicious, tended to come into bearing later and was more susceptible to frost injury.

5. Ruby and Gallia Beauty bore early, annually, and quite heavily.

These results are important in view of their relationship to: (1) selection of cultivars for planting in Ohio orchards, (2) distance of planting of certain cultivars on Malling VII, and (3) selection of semi-dwarfing or very dwarfing stocks for certain cultivars. For maximum yields per acre, Gallia Beauty and Ruby undoubtedly should be planted more densely on Malling VII than Melrose, Stayman Winesap, and Starking and its mutations. This may involve a difference as great as 50 trees per acre. Within the same planting, the difference may mean a shorter distance between trees in the row with Gallia Beauty than with Melrose.

The question may also be raised as to whether a more dwarfing rootstock might well be utilized for Melrose and the Stayman and Delicious groups than for Gallia Beauty and Ruby. With Delicious, the choice between spur and non-spur types obviously will make a considerable difference in the choice of stocks. In the experiment reported here, the non-spur type Starking was utilized. This cultivar would be comparable to Topred, Royal King, Royal Queen, Red Prince, Chelan Red, and Richared.

These results also indicate the possible value of propagating Delicious and its non-spur type mutations on Malling 26. Insufficient data are available as to suitability of this dwarfing rootstock for the cultivars naturally producing large trees. However, under very favorable growing conditions, Malling VII produces a large sized tree. Yet, close planting of trees on this stock may be the best solution providing the trees are "fanned" when pruned in later years. This involves the heading back of side branches between the trees within the rows.

Fruit Crops Research--1969. Part II. Tree Fruits. Research Summary 36, Ohio Agricultural Research and Development Center, Wooster, Ohio. July 1969.

TOTAL YIELD AND TRUNK CIRCUMFERENCE OF JONATHAN, GOLDEN DELICIOUS, AND RED DELICIOUS ON MALLING IX, 1956-1968

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Jonathan, Golden Delicious, and Red Delicious propagated on Malling IX were planted at Horticultural Research Unit No. 2 during the 1956-57 period. The planting distance is 10 feet in the row and 18 feet between rows.

These trees were originally involved in an experiment to ascertain the effects of flower removal during their early years upon sufficient growth and yield. The results were generally inconclusive, since removal of the flowers for 1 or 2 years did not result in significantly greater growth than that which occurred when the trees were allowed to bear in successive years.

These trees were planted in sod and have been maintained with the addition of annual applications of a nitrogen-carrying fertilizer. Only hand thinning has been carried out during the entire period.

Jonathan yields have been annual and have been proportionate to increasing tree size. Golden Delicious at first bore annually and then became biennial. The trees again are tending to annual bearing. Red Delicious (strain unknown) came into bearing a little later and some loss of fruit due to late spring frost occurred.

The total accumulative yield per tree and average trunk circumference through 1968 are presented in Table 1. The relationship of yield to 1 inch of trunk circumference is also calculated.

Table 1 shows that Golden Delicious produced the largest accumulative yield per tree. It was followed by Jonathan and Red Delicious,

TABLE 1.--Total Accumulative Yield and Trunk Circumference of Jonathan, Golden Delicious, and Red Delicious on Malling IX, 79-91 Trees, 1956-1968.

Cultivar	Average Yield per Tree (lb.)	Average Tree Circumference (inches)	Average Yield to 1 Inch of Trunk Circumference
Golden Delicious (1957)	388.2	10.0	39.0
Red Delicious (1957)	341.3	10.8	31.5
Jonathan (1956)	338.5	9.9	34.3

which did not differ significantly in this respect. Red Delicious produced the largest trees, followed by Golden Delicious and Jonathan, which were essentially similar in size.

As expected, Red Delicious showed the lowest yield to 1 inch of trunk circumference and Golden Delicious showed the highest yield. Jonathan was intermediate. Golden Delicious showed this result despite its tendency to show some alternate bearing after the first few years.

From present evidence, the planting distance for Jonathan and Golden Delicious could have been 8 feet between trees in the row and 16 feet between rows. On the other hand, the planting distance for Red Delicious was satisfactory at the 10 x 18-foot distance. This lower planting distance with Jonathan and Golden Delicious would have permitted 340 trees per acre. On this basis, the accumulative yield per acre for the period would have been 2,398 bushels for Jonathan and 2,749 for Golden Delicious. For Delicious at 242 trees per acre, the accumulative yield would have been 1,725 bushels. These yields indicate the extent to which high yields per acre can be obtained by utilizing the very dwarfing Malling IX at the closest possible distance between trees in the row and between rows.

Fruit Crops Research--1969. Part II. Tree Fruits. Research Summary 36, Ohio Agricultural Research and Development Center, Wooster, Ohio. July 1969.

FOUR SELECTED APPLE SEEDLINGS
RECEIVING ACCELERATED EVALUATION

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Four apple seedlings possibly well adapted for commercial planting are being given accelerated evaluation. Because of their particularly favorable fruit characteristics, they have already been propagated on very dwarfing Malling IX and will be extensively propagated in 1969 on Malling 26, Malling VII, and Malling Merton 106. Three of these seedlings have been examined in detail annually for 8 to 10 years. In 1969 they were made available to the Plant Material Exchange Committee of the American Pomological Society. These seedlings are, because of their importance, recommended for trial in those regions where Jonathan and Delicious do well.

It has been previously pointed out that the major objective of the Ohio apple breeding program was changed from attempting to obtain late blooming progeny to emphasizing extensive red over-color of the fruit coupled with good fruit quality characteristics. Although this objective has not been completely attained, outstanding progress has been made. Of the many combinations utilized, Jonathan and Delicious have been most effective in producing well-colored seedlings of good quality. Practically any other cultivar has reduced rather than increased red over-color of the progeny.

Fig. 1.--Typical tree of Seedling No. 7313. Parentage--Richared x Jonathan.

The major fruit characteristics of these four selected seedlings are as follows:

SELECTION NO. 7313: Parentage--Richared x Jonathan. Size--Medium to large. Shape--Oblate to oblong uniform. Similar to Jonathan in this respect. Color--Scarlet to Crimson. Solid and covering practically the entire surface. Flavor--Good to very good, sweet to subacid, more subacid than Delicious and similar to Jonathan. Juicy, excellent texture. Harvest Date--October 2 to 8.

SELECTION NO. 8408: Parentage--Jonathan x Delicious. Size--Medium to large. Shape--Oblong to oblong-conic, somewhat similar to Delicious. Reasonably symmetrical. Color--Cherry red to dark red covering the entire surface. Flavor--Sweet to subacid and quite juicy, resembling Delicious, good to very good. Texture of flesh excellent. Harvest Date--October 20.

SELECTION NO. 8481: Parentage--Jonathan x Delicious. Size--Medium to above medium. Shape--Oblate to oblong-conic, sides may be slightly unequal. Color--Cherry red extending over the entire surface. Flavor--Sweet to subacid, slightly resembling Delicious, good to very good. Harvest Date--October 4.

SELECTION NO. 13052: Parentage--Starking x Franklin. Size--Medium to above medium. Shape--Rounded to oblong-conic, sides may be slightly unequal, resembles Delicious. Color--Solid dark red spread over the entire surface. Flavor--Juicy, sweet to subacid, fair to good. Harvest Date--October 16.

Several other seedlings have been observed for several years and offer promise. These will be propagated in 1969 on Malling IX and Malling 26. A total of 233 seedlings are being held for continuous evaluation.

Buds of the four selections are available for limited observation. It is suggested that these be placed on very dwarfing rootstocks in order to permit early observation of their fruit characteristics under the particular environmental conditions involved.

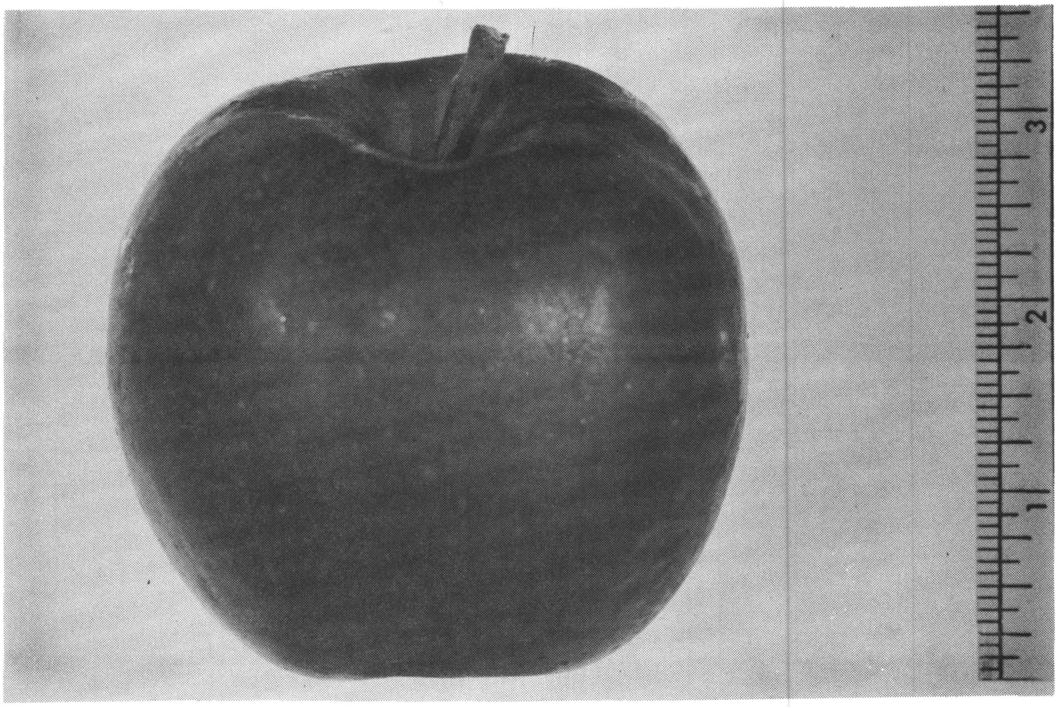

Fig. 2.--Typical fruit of Seedling No. 8408.
Parentage--Jonathan x Delicious.

Fig. 3.--Typical tree of Seedling No. 8408.
Parentage--Jonathan x Delicious.

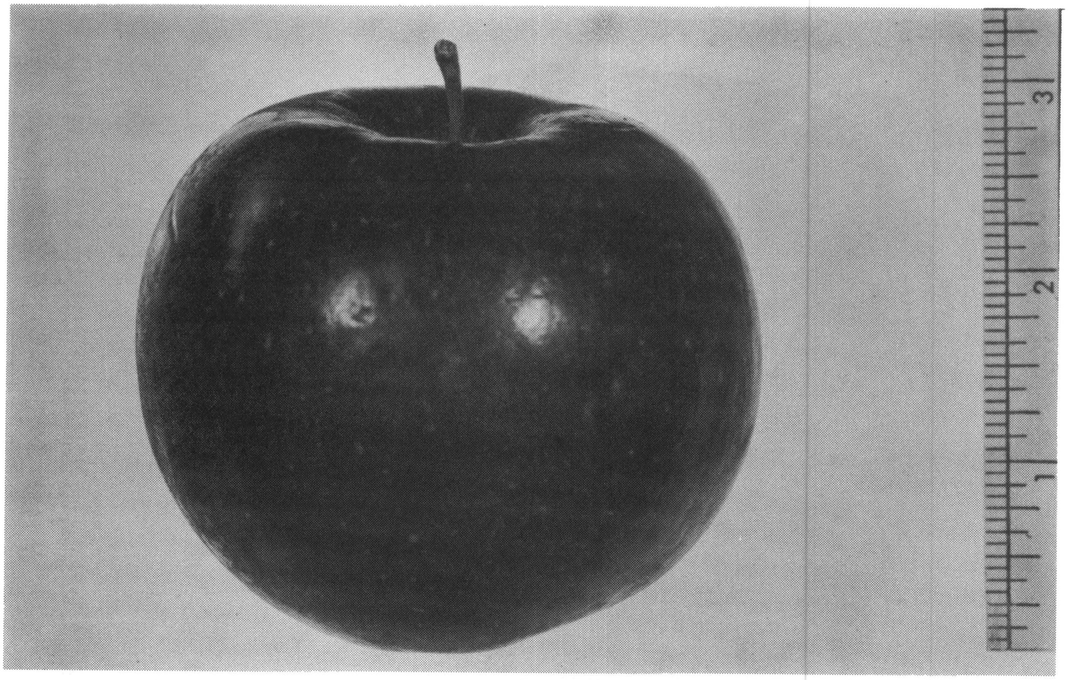

Fig. 4.--Typical fruit of Seedling No. 8481.
Parentage--Jonathan x Delicious.

Fig. 5.--Typical tree of Seedling No. 8481.
Parentage--Jonathan x Delicious.

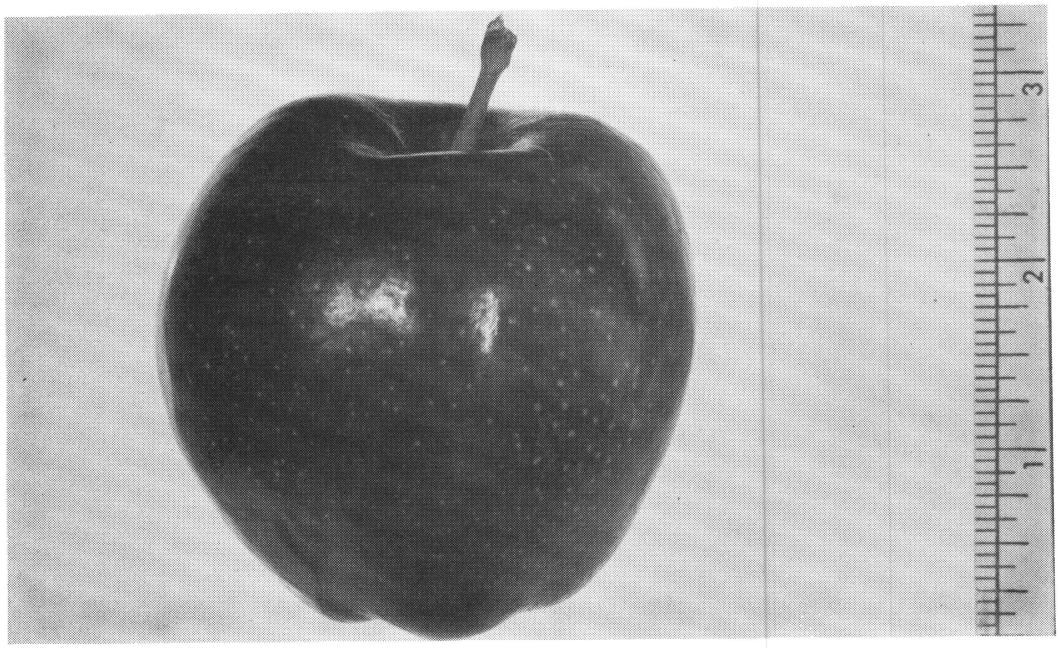

Fig. 6.--Typical fruit of Seedling No. 13052. Parentage--Starking x Franklin.

Fig. 7.--Typical tree of Seedling No. 13052. Parentage--Starking x Franklin.

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MAINTENANCE COLLECTION OF NEW APPLE MUTATIONS AND CULTIVARS

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The maintenance of new apple strains and cultivars has been one of the minor projects of the Department of Horticulture. It particularly includes bud mutations of Delicious which have been obtained either personally or from very reliable sources which insure that these are true to name. Very shortly after a bud mutation or "sport" is observed, it is possible for it to become confused with other strains and its identity lost forever. For this reason, this collection at the Research Center involves only those known to be true to name.

An outstanding example of a cultivar which in reality is an unknown mutation is one obtained by the Research Center in 1957 called "Double Red Delicious." Actually it is not known what strain or mutation of Delicious this happens to be. As time passes, increased examples of this loss of identification undoubtedly will occur.

A number of strains or mutations of Delicious as well as certain other new cultivars have been established at Horticultural Research Unit 2 and at Unit 1 (South Farm). At the latter unit, propagation has been largely made on Malling IX. A few were propagated later on Malling 26.

Fig. 1.--Typical tree of Holiday on very dwarfing Malling IX, 1968. Planted in 1963.

Fig. 2.--Typical tree of Golden Delicious on very dwarfing Malling IX, 1968. Planted in 1963.

The following cultivars have been placed on <u>Malling IX:</u>

Barry

C. and O. Red Rome

Chelan Red (Delicious Mutation)

Franklin

Gardner Delicious (Delicious Mutation)

Golden Delicious

Houser (Delicious Mutation)

Hi-Early Red (Delicious Mutation)

Holiday

Greendale

Imperial Red (Delicious Mutation)

Jardine (Delicious Mutation)

Jonathan

Kidd's Red Orange

Lalla (Delicious Mutation)

Melrose

Myrtle (Delicious Mutation)

Niagara

Nickell (Delicious Mutation)

Ohio Seedling 7428 (Richared x Golden Del.)

Patricia

Red King (Delicious Mutation)

Red Prince (Delicious Mutation)

Red Queen (Delicious Mutation)

Red Spur (Delicious Mutation)

Royal Red (Delicious Mutation)

Ruby

Rypzynski Strain (Delicious Mutation)

Spencer

Spigold

Starking

Starkrimson (Delicious Mutation

Tydeman's Red

Wayne

Wellspur (Delicious Mutation)

<u>Malling 26</u>

Chelan Red (Delicious Mutation)

Close

Double Red Jonathan

Golden Delicious

Jonalicious

McIntosh (Rogers Strain)

Red Gold

Ruby

Rypzynski (Delicious Mutation)

Spartan

Splendor

Starking

Sundale (Golden Delicious Mutation)

Stark Red Gold

Stark Splendor

Fig. 3.--Typical tree of Franklin on very dwarfing Malling IX, 1968. Planted in 1963.

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WITHIN-TREE VARIATIONS IN MATURITY OF STARKING APPLES

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Respiration rate of apple fruits is the only reliable method for determining harvest maturity and predicting post-harvest storage life. The general pattern of fruit respiration from full bloom to senescence is illustrated in Fig. 1. Apple fruits are mature when the respiration rate has reached a minimum level, referred to as the "climacteric minimum." Fruits harvested at this point are not "eating ripe" but will ripen to maximum quality. Further, these fruits have maximum potential storage life.

Fruits harvested during the climacteric rise in rate of respiration have a progressively more favorable eating quality but also have a decreasing potential storage life. Fruits which have reached the "climacteric maximum" when harvested will have developed maximum eating quality but will have a very short storage potential.

It is generally desirable to harvest all fruit on a tree at a single picking to fully utilize available labor. However, all fruits

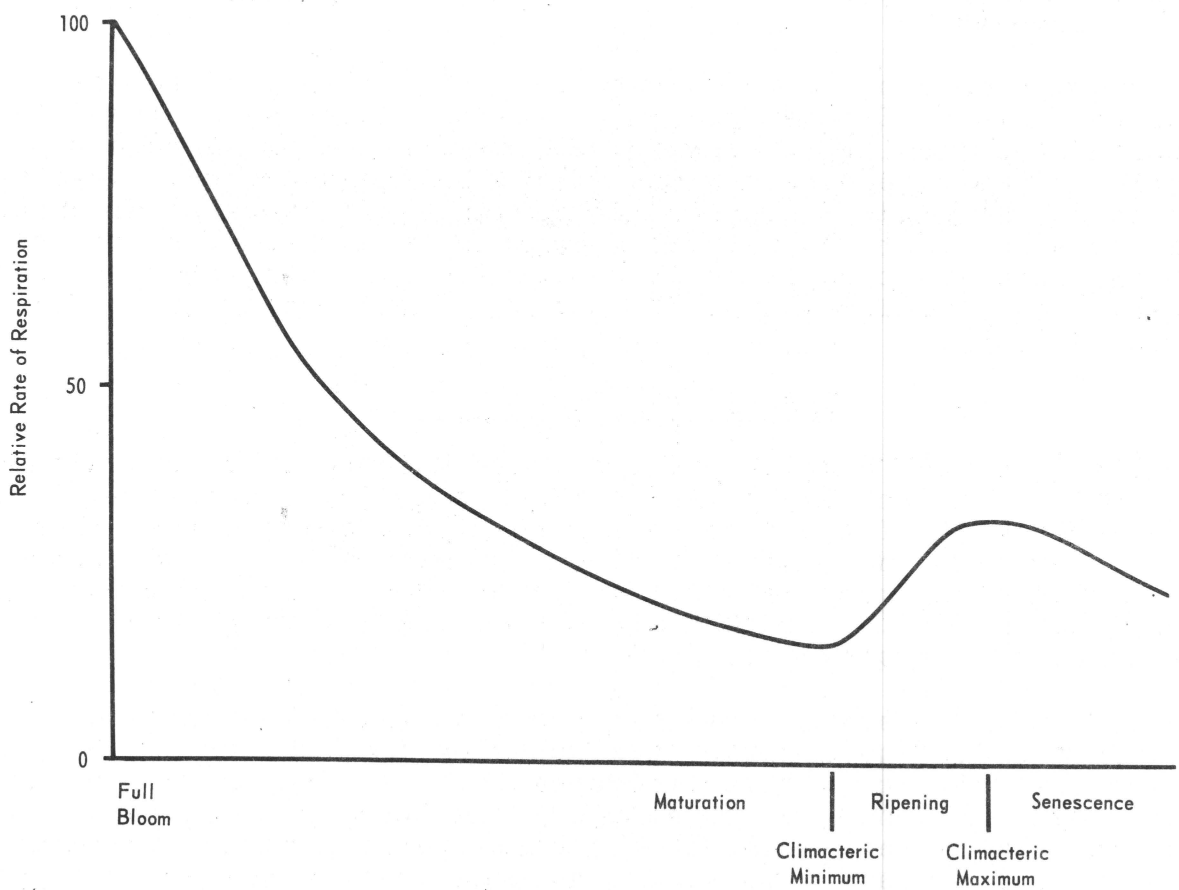

Fig. 1.--A schematic relationship of development to rate of respiration of apple fruit from full bloom to senescence.

on a tree do not mature at the same time. This prevents picking fruit with the same maturity in a once-over harvest. Uneven maturity also complicates the use of rate of respiration as a means of determining fruit maturity on a tree and within an orchard.

During the progress of investigations on apple fruit maturity, results indicated that certain cultivars had very wide ranges of fruit maturity within trees. Cultivars in the fruit maturity study are McIntosh, Franklin, Jonathan, Starking, Golden Delicious, Melrose, Stayman Winesap, and Rome Beauty. Of these cultivars, McIntosh, Franklin, and Starking have had the greatest within-tree variability in fruit maturity. Therefore, a preliminary study was designed to determine the location (part or parts of a tree) of greatest variability in maturity for one of these cultivars. The results would greatly assist in determining the proper choice for sampling in OARDC studies as well as for fruit growers to determine harvest maturity in their own orchards.

METHODS

Starking was selected for the preliminary study because of the relative importance of strains of Delicious as commercial cultivars in Ohio. A single tree which has been a part of maturity prediction studies for 4 years in Orchard A of Horticulture Unit 1 at the Research Center was arbitrarily divided into an upper and a lower half. These halves were then subdivided into quarters equivalent to the four quadrants on a compass.

A random sample of 12 fruits was picked from each of the eight parts of the tree on October 3, 1967. These samples were placed in the Department's respiration chamber system for determing rate of respiration. Fruit temperature was 70° F. in the chambers. Readings were taken 24, 48, and 72 hours after picking. The data were compared to those obtained from the regular samplings taken from the tree as part of the maturity prediction investigation. Fruits for this latter study were picked randomly around the base of the tree, 5 to 6 ft. above ground level.

RESULTS AND DISCUSSION

Fruits from each sample appeared quite uniform in color, although considerable variation was evident between samples. Generally, fruits from the upper half of the tree were more highly colored than those from the lower half and fruits from the southwest (S.W.) and southeast (S.E.) quadrants had more red surface color than fruits from the two northern quadrants (N.W. and N.E.). No differences in ground color between samples were apparent.

Data from the respiration determinations (Fig. 2) indicated that fruits from the S.W. quadrant of the upper half of the tree were past the climacteric minimum. This indicates that the fruits were mature and beginning to ripen. Fruits sampled from the upper S.E. and lower S.W. quadrants were very close to the climacteric minimum and ready to begin their respiratory rise. This suggests that these fruits were at optimum maturity for harvest for maximum storage life. Fruits from the upper N.E. and N.W. quadrants and the lower S.E. quadrant were at approximately the same stage of maturity, just approaching the climacteric minimum when picked. Fruits from the northern side of the lower half of the tree showed a very uneven respiratory pattern. This type of respiratory pattern indicates a very wide range of maturity of the fruits within a sample.

The respiratory patterns of the fruits sampled from the same tree for the regular maturity prediction study are presented in Fig. 3. These data suggest that the climateric minimum for the sampled fruit was around October 5, 1967. This is supported by observations after 6 months of storage at 32° F., since fruits from that sampling date had the highest quality rating after storage. Quality was based upon color, firmness, crispness, and flavor. It should be pointed out that red surface color was generally greater from the later sampling dates

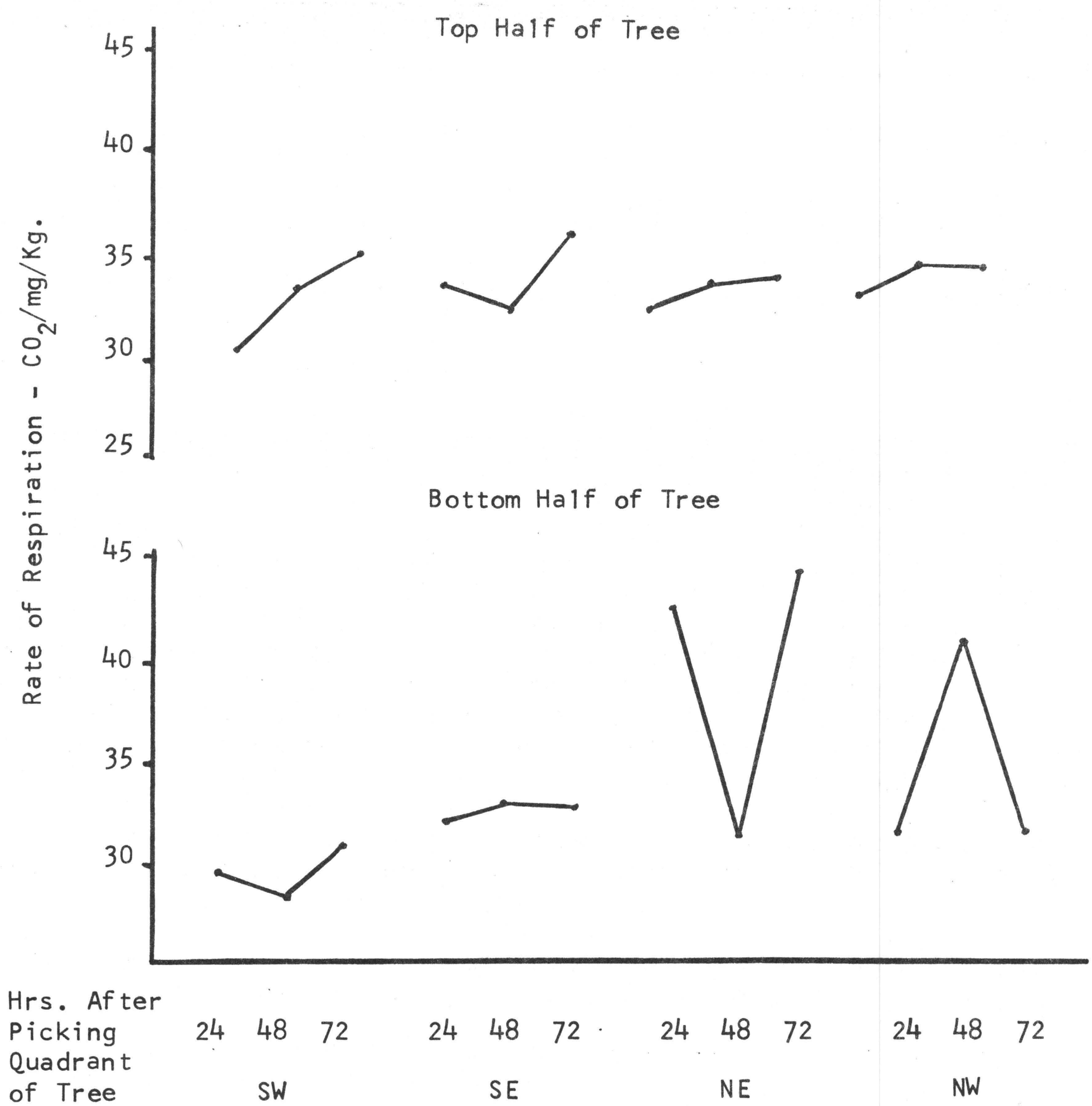

Fig. 2.--Respiration rates of Starking apple fruits sampled from four quadrants of the upper and lower halves of a tree on October 3, 1967. Readings were taken 24, 48, and 72 hours after removal of fruits from the tree.

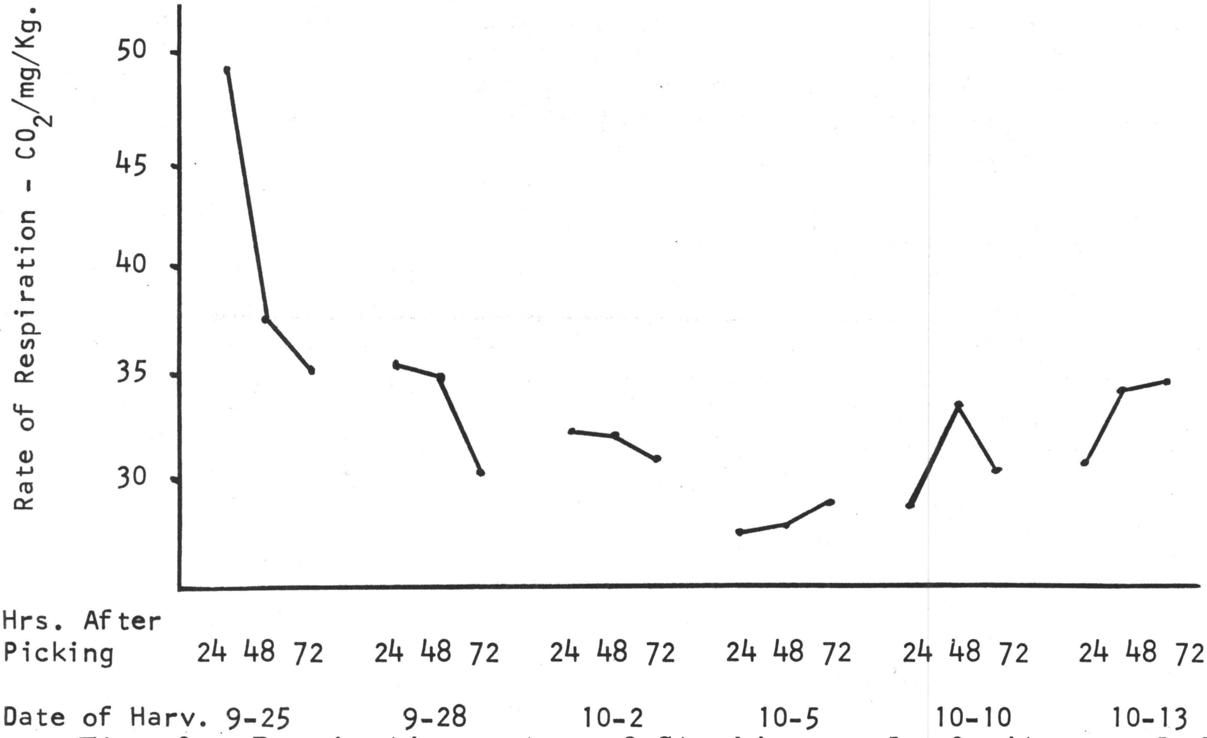

Fig. 3.--Respiration rates of Starking apple fruits sampled randomly around the lower portion of the tree during a 3-week period in 1967. Readings were taken 24, 48, and 72 hours after removal of fruits from the tree.

but other quality factors had deteriorated at a greater rate during the 6-month storage period.

Results of this preliminary study suggest that for determining an "average" harvest maturity on Starking apples based upon rate of respiration, fruits sampled from the lower S.E. quadrant of the tree would provide the most representative sample of the majority of fruits on the tree. It should be remembered, however, that some fruits from the upper S.W. quadrant will be in a more ripened condition and probably will not keep as long in storage. Further, fruits from the northern side of the lower half of a tree will be somewhat less mature and poorer quality when ripened.

These data also indicate that when spot-picking for maturity, early picking should be concentrated in the upper portion of the tree, especially in the S.W. quadrant.

It has not yet been established that this same type of relationship holds true for other apple cultivars but experience suggests that it could.

Fruit Crops Research--1969. Part II. Tree Fruits. Research Summary 36, Ohio Agricultural Research and Development Center, Wooster, Ohio. July 1969.

APPLE SCAB CONTROL WITH MASSIVE-DOSE APPLICATIONS OF FUNGICIDES

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Massive-dose application is the application of a fungicide at rates from 12 to 24 times the normal rate used in standard protective programs. Massive-dose application results in application of large amounts of liquid and fungicide per tree. This mode of application should not be confused with normal concentrate application in a standard protective program, which employs high concentrations of fungicide in the sprayer tank but which delivers relatively small amounts of liquid and fungicide per tree.

In the 1967 and 1968 seasons, workers in several states reported that a single massive-dose application of the experimental fungicide Difolatan, applied at the half-inch green (delayed dormant) stage of blossom bud development, considerably reduced apple scab on both fruit and foliage. Addition of oil to massive-dose applications seemed to increase the fungicidal effectiveness and did not result in injury unless application was made later than the half-inch green stage. A single massive-dose application of a commonly used scab fungicide, Cyprex, also reduced scab incidence.[1/] Single massive-dose applications of these two fungicides did not result in commercially-acceptable scab control. However, when single massive-dose applications of Difolatan were followed by applications of standard protective fungicides later in the season, commercially acceptable scab control was achieved.

Single massive-dose application of a scab fungicide, applied in combination with a 70-second viscosity Superior oil and supplemented by a regular protective program beginning at about petal fall, would be extremely advantageous to growers. Because apple sprays prior to petal fall (with the exception of the oil spray for mite control) are usually applied exclusively for the control of scab, pre-bloom and bloom spray applications could be eliminated by the use of a massive-dose application. A regular protective program for scab control could begin at petal fall, when insecticide applications are required. This would eliminate three to five sprays and would be advantageous to the grower both because sprays are costly to apply and because heavy rains in the pre-bloom and bloom period often make it difficult to travel through orchards with heavy spray machinery.

There was only limited experience with massive-dose application supplemented with later sprays for scab control during the 1968 season. Massive-dose applications of Cyprex had not been tested with supplementary sprays and rates of Difolatan were believed to be higher than necessary for supplemented application.

In 1969, massive-dose applications of fungicides for apple scab were made for the first time in Ohio. Difolatan and Cyprex were applied

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[1] Difolatan and the massive-dose application of Cyprex have not been cleared for use on apples.

with oil at half-inch green to mature Cortland trees on April 14. All applications were made with hydraulic equipment, using a hand gun to apply material to single-tree plots. Massive-dose rates were 5 quarts (5 lb. active) of Difolatan 4 Flowable per 100 gallons of spray and both 4 and 5 lb. of Cyprex 65W (2.6 and 3.25 lb. active).

Massive-dose treatments were compared with standard scab control programs (Cyprex throughout the season and Cyprex followed by captan) and no treatment (check). Massive-dose schedules received four fewer spray applications in the pre-bloom and bloom periods than standard schedules and were supplemented with either four applications of Cyprex 65W at 0.5 lb. or with the standard captan schedule. These supplementary programs began on May 16 (about 4 days after petal fall) and were applied at the recommended intervals (no supplementary Cyprex was applied, however, after the third cover spray). One massive-dose treatment of Difolatan was supplemented with the Cyprex program and another with the captan program. The two 4 lb. massive-dose Cyprex treatments were similarly treated while the single 5 lb. treatment was supplemented with the Cyprex program.

Visual observations made during the third week of June indicated that all massive-dose applications greatly reduced scab in a year when unsprayed trees were heavily infected. Some foliage and fruit scab did occur, however, on all massive-dose treatments. Somewhat less scab was observed with standard programs.

Leaf infection data were recorded but the commercial practicality of massive-dose application cannot be truly assessed or comparison of treatments be fairly made until harvest. It should be noted that the early part of the 1969 season was very favorable for the development of apple scab and applications of supplementary scab control programs were not made until after petal fall. Thus, proper timing of supplementary programs could reduce scab incidence with massive-dose application to that level obtained with the use of standard programs. Another factor to consider in the commercial practicality of massive-dose fungicide application is application with the air-blast sprayers used by nearly all growers. In previous experiments in other states and in the present one in Ohio, hydraulic equipment was used.

Fruit Crops Research--1969. Part II. Tree Fruits. Research Summary 36, Ohio Agricultural Research and Development Center, Wooster, Ohio. July 1969.

ADVANCES IN ORCHARD WEED CONTROL

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The development of chemical techniques for the control of weed growth under fruit trees has done much to improve the efficiency of production. These techniques, developed through the efforts of the agricultural chemical industry and various state and federal institutions, have not only allowed Ohio fruit producers to maintain their place in modern agriculture but have done much to assure consumers of adequate supplies of fruits at reasonable costs.

The use of chemical weed control procedures is widely accepted. In a relatively few years, they have been adopted by most growers as a normal management practice. However, the full potential of such procedures has not been gained and such techniques must therefore be considered still in a developing stage. Research efforts are continuing to overcome problems of timing and continued use and to develop new chemical tools for use in orchard plantings.

One of the more important advances has been the granting of label approval for the use of Dual Paraquat (Paraquat bis (methylsulfate)-[1,1'-dimethyl-4,4' bipyridinium bis (methylsulfate)] under bearing fruit trees. It has been approved for such use at the rate of up to 1 lb. per acre of sprayed area under all fruit trees grown in Ohio. The worth of this compound as a weed control agent has been well documented by extensive research activities and grower experience.

Paraquat gives a rapid knockdown, almost immediate, of any vegetative growth. To be effective, it must be applied to such weed growth when it is succulent and still small enough to be thoroughly wetted. It is essential that a good surfactant be included with Paraquat in the spray mix if satisfactory results are to be obtained.

Paraquat is an excellent chemical tool. It is recommended for use under all fruit trees. Under Ohio conditions, 3/4 lb. or 3 pints of Paraquat, plus 8 oz. or one cup of X77 per 100 gallons per acre of spray, has proven most satisfactory. There is no restriction as to time that application can be made. Repeat applications can be made as required throughout the season.

The major limitation in the use of this compound is that it has no residual value. Regrowth seedlings can and will develop in treated areas. This problem can be effectively overcome by the application of some good approved residual-type herbicide following the Paraquat applications. Experimentally, in-tank mixes of Paraquat plus X77 plus a residual herbicide have proven most effective. However, such combinations have not received label approval and hence must be considered still on an experimental basis.

Paraquat must be used with much more caution than most herbicides--precautions such as those which growers have learned to accept in the use of some of the common insecticides. If mishandled, Paraquat can be hazardous to the applicater. Reports indicate that it can cause serious bodily harm. Caution must be used when applying it to avoid contact with either the concentrate or the dilute mixture. Particular care must be exercised to avoid inhalation of the spray drifts. Paraquat is not a compound to fear or avoid but is simply a compound which must be used with respect.

Recent field trials have indicated that certain under-tree weed control materials may serve the fruit grower in additional ways. In some instances, particularly where it is desirable to plant in sod, herbicides may be substituted for cultivation in site preparation. The same principles are involved as in the increasingly popular "no tillage" system for corn.

In the establishment of a small, closely spaced research apple planting, this approach was utilized. The orchard was to be established on a site supporting a strong sod, which included a range of grasses and broad leaves. In order to test the concept, 3-4 foot wide bands (the future row areas) were treated with Paraquat at the rate of 1 lb. per acre in late fall, after the harvest season. This treatment effectively controlled the sod cover that fall. Just prior to planting time the next spring, these areas were re-treated in the same fashion to eliminate interference with planting by spring weed growth. Individual tree holes were dug and the trees were set. The trees grew well. During that summer, control of competing species within the tree rows was maintained chemically and the sod was kept closely clipped.

This approach to orchard establishment has much merit and is well worthy of further consideration. It not only offers a simplified, more efficient means of site preparation but it also offers site preparation without the hazards of erosion and damage to soil structure associated with the more conventional, physical methods of preparation.

With continued use of specific herbicides in the orchard environment, it has become apparent that the ecology within the treated areas changes. Some species, which prior to the beginning of the program are unnoticed original populations because of their tolerance to the herbicides, increase rapidly in number and become as troublesome as the populations which they have replaced.

From these observations in OARDC research orchards and observations in grower orchards, it becomes apparent that if such problems of escaping or tolerant weeds are to be avoided, a "rotation" or alternation of herbicides applied must be followed. Fruit growers must not think in terms of one herbicide but must think in terms of an herbicide program for their orchards. Just as there is no one insecticide, there is no one herbicide that will do the job year after year.

Concepts of orchard weed control have gone through a remarkable change in a brief period. They have changed rapidly from a novel approach to accepted grower practice. The number of usable herbicides has increased just as rapidly.

Today the use of herbicides should best be considered a matter of soil management practice. Herbicides may well be considered "chemical tools". As with other tools, the one to use depends upon the job to be done.

It can be anticipated that there will be even better chemical tools made available for orchards. As this area of orchard management continues to develop, it will be important that the producer be as alert to this aspect of his production practices as he is to the more conventional use of pesticides in his plantings.

Fruit Crops Research--1969. Part II. Tree Fruits. Research Summary 36, Ohio Agricultural Research and Development Center, Wooster, Ohio. July 1969.

SEASONAL ABUNDANCE OF APPLE AND CHERRY FRUIT FLIES

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Before control measures for an insect pest can be developed, its biology and life history must be studied thoroughly. Armed with this information, an entomologist can recommend more effective controls.

This is the case with apple and cherry fruit flies. These insects cause fruit injury which at first is inconspicuous externally. When egg punctures are finally noted, the damage may be very extensive. The flies themselves often are not noticed soon enough for growers to begin effective control measures. Therefore, it is up to an entomologist to determine when insecticide sprays are first needed and what subsequent applications are necessary. From the results of life history studies, the present recommendations are suggested. Continued biological studies are also necessary to determine if the recommendations continue to be valid or if slight changes are needed because of changing trends in the life history.

This paper reports the results of life history studies on three species of fruit flies: apple maggot, *Rhagoletis pomonella*: black cherry fruit fly, *R. fausta*; and cherry fruit fly, *R. cingulata*.

Standard sticky board bait traps were hung in trees of unsprayed orchards. At regular intervals throughout the season, the number of adult flies trapped were counted. Table 1 shows the data collected on the apple maggot and Table 2 summarizes the cherry fruit fly results.

The present recommendations on the apple maggot include specific insecticide sprays in late June, mid-July, late July, mid-August, and even in late August (approximate times in northern Ohio). The trapping records indicate that the first adult fly emerges from the soil in late June. Based on the date of apple bloom, the first adult fly was trapped about 51 days after bloom.

After spending 10 to 14 days feeding and mating, the female begins to lay eggs in apples. The first recommended spray is intended to kill the first flies before they lay eggs. As the season progresses, more flies emerge from the soil and others fly into the orchard from abandoned, unsprayed apple trees. Major trapping periods or major flights have been noted in mid to late July and again in late August to early September. The latter period of abundance is the reason why a late August spray is important. Since the residual effectiveness of an insecticide lasts from 2 to 3 weeks, the late August spray should be sufficient to control the decreasing numbers of apple maggot flies which are found in September and early October. Very few new adults emerge from the soil in September. However, in orchards with some early apple varieties which are infested, a partial second generation of flies may appear, resulting in a rather substantial fly population in late season.

There are two species of cherry fruit flies. The black cherry fruit fly appears to be active much sooner than the cherry fruit fly.

TABLE 1.--Approximate Dates in Apple Maggot Life History.

	Wayne Co.			Lake and Ashtabula Counties		
	1966	1967	1968	1966	1967	1968
1st Adult	6/30	6/22	7/2	6/24	6/27	6/25
1st Major Flight	7/29	--	7/17	7/12	7/23	7/23
Last Major Flight	8/20	--	9/3	8/18	9/2	9/4
Last Adult	10/10	10/2	9/24	10/5	10/9	10/28
Estimated Date of Apple Bloom	5/14	5/1	5/1	5/18	5/4	5/3

TABLE 2.--Approximate Dates in Cherry Fruit Fly Life History.

	Lake County		
	Black Cherry Fruit Fly		Cherry Fruit Fly
	1967	1968	1967
1st Adult	6/8	6/2	6/23
Peak Abundance	6/16	6/11, 6/20	7/5
Last Adult	7/7	7/4	7/18
Estimated Date of Sweet Cherry Bloom	4/20	4/14	4/20

The recommended sprays for both species in northern Ohio include one in late May (first cover), followed by two more. Following the same reasoning as for the apple maggot, the importance of all sprays can be seen. It is also obvious why a post-harvest spray is necessary if there is fruit left on the trees. The cherry fruit fly is still present in peak numbers during the first week in July. In this study, the last adult was captured in mid-July.

For further details on the insecticides to use and control recommendations, refer to Ohio Cooperative Extension Service Bulletin 506, 1969 Fruit Spraying Recommendations.

Fruit Crops Research--1969. Part II. Tree Fruits. Research Summary 36, Ohio Agricultural Research and Development Center, Wooster, Ohio. July 1969.

OHIO FRUIT INDUSTRY TRENDS AND THEIR RELATIONSHIP TO RESEARCH

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The Ohio State University

The fruit industry in Ohio is undergoing rapid changes and adjustments, quite similar to those in other states and countries. Many of the problems and situations confronting Ohio producers are very much like those needing attention in other areas. A change or shift in the kind and number of cultivars planted, in the type of rootstock used, or in tree spacings and planting distances may, and often does, require a change in research programs. The opposite is likewise true--the products of research are basic causes of changes and trends in the industry.

Three fruit tree surveys have been conducted in Ohio during recent years--in 1959, 1965, and 1968. Each survey contains statistics pertaining to cultivars, numbers, types and ages of apple, peach, and cherry trees, as well as number, size, and distribution of orchards in the state. The surveys of 1959 and 1968 also include similar statistics on grapes in Ohio. Each has been conducted jointly by the U.S. Department of Agriculture Statistical Reporting Service and the Ohio Department of Agriculture.

A summary and comparisons of some of the statistics from the three surveys are presented in the following tables. Table 1 compares orchard and vineyard numbers, number of acres, and number of trees and vines reported in the three surveys.

The surveys reveal a slight downward trend in acres, tree numbers, and numbers of orchards and vineyards from 1959 to 1968. There was a slight rise in these statistics in 1965 for apples and cherries. The most striking reduction occurred in peach tree numbers, where there has been about a 32% reduction since 1959. This can be largely accounted for by the severe low temperature injury to peach trees in the winter of 1962-63. Many injured trees were removed in 1963-64 but many more remained until later for removal. New peach plantings have not been at a sufficient rate to offset the trees lost directly and indirectly from the 1962-63 effects. Although statistics are not available, the 1969 peach tree plantings seem to be rather large in comparison with those of recent years.

Since much of agricultural research is designed to solve existing problems and to prevent the development of new or anticipated problems, the trend in tree numbers indicates probable areas for research emphasis. Two such areas which appear to be in need of more intensive research are:

1. Winter hardiness of peach cultivars and rootstocks.

2. Frost protection methods for orchards and small fruits.

Tables 1 and 2 indicate a significant trend towards planting more apple cultivars on size-controlling rootstocks. There is also a decided trend to increased plantings of spur-type trees of cultivars where these are available, such as Delicious and Golden Delicious. This trend presents several implications for needed research to assist Ohio fruit producers. Among those to be considered are:

1. Tree spacing and planting designs for maximum efficiency in production practices and maximum yields of high quality fruit.

2. Tree training systems and pruning procedures for given tree sizes which will maximize the yield of high quality fruit per tree, utilizing mechanization to as great a degree as possible for achieving greatest labor efficiency. Such research is needed for peaches and other stone fruits, as well as for apples.

3. Mechanized harvesting of all fruits for processing and mechanized assistance to hand picking of apples for fresh market selling.

Crop Reporting Districts

TABLE 1.--Comparison of Ohio Fruit Survey Statistics, 1959, 1965, and 1968.

Kind of Fruit	No. Orchards or Vineyards			No. of Acres			No. of Trees or Vines		
	1968	1965	1959	1968	1965	1959	1968	1965	1959
Apples--Total	-	594*	754	14,908	15,887	15,583	590,299	610,360	527,470
Standard	551	584	-	12,521	14,506	-	444,543	520,400	-
Semi-Dwarf	254	181	-	2,387	1,381	-	145,756	89,960	-
Peaches	439	489	708	3,809	5,646	5,815	323,148	455,000	476,740
Tart Cherries	128	67	63	411	539	428	33,127	45,120	30,980
Sweet Cherries	89	43	-	71	94	-	4,797	6,320	-
All Cherries	217	110	-	482	633	-	37,924	51,440	-
Grapes	340	-	394	3,665	-	4,135	2,139,710	-	2,436,480

*Orchards with all types of apples are accounted for in each subtotal but are counted as one unit in the total number.

TABLE 2.--Comparison of Apple and Peach Trees by Districts, 1959, 1965, and 1968.

District and County	Standard Apple Trees 1968	Standard Apple Trees 1965	Standard Apple Trees 1959	Semi-Dwarf Apple Trees 1968	Semi-Dwarf Apple Trees 1965	Semi-Dwarf Apple Trees 1959	Peach Trees 1968	Peach Trees 1965	Peach Trees 1959
Northwest	8,760	7,760	5,470	4,402	--	--	14,315	16,940	10,320
North Central	82,327	103,070	101,440	25,127	22,190	8,380	103,267	144,290	167,230
Erie	18,219	24,570	--				20,137	31,250	--
Lorain	21,074	24,330	--		County Statistics Not Available		11,953	18,210	--
Ottawa	10,175	24,570	--				26,118	41,540	--
Sandusky	14,261	14,760	--				36,008	31,670	--
Other	18,598	14,840	--				9,051	21,620	--
Northeast	146,794	183,260	195,340	41,059	23,640	6,350	96,916	137,140	131,390
Ashtabula	23,749	21,600	--				21,217	21,450	--
Columbiana	38,350	46,300	--				21,391	36,820	--
Lake	7,480	17,780	--				10,608	17,670	--
Mahoning	20,556	29,560	--		County Statistics Not Available		5,081	12,230	--
Stark	19,801	21,980	--				23,022	18,900	--
Other	36,858	46,040	--				15,597	30,070	--
West Central	15,939	20,390	15,080	1,923	--	--	6,020	5,350	3,920
Central	63,539	58,630	51,570	33,807	10,510	2,150	22,801	18,240	29,180
East Central	43,546	39,420	48,290	9,895	15,420	2,590	21,356	32,720	25,150
Southwest	24,652	30,220	35,730	5,945	--	590	12,621	28,450	26,660
South Central	28,980	41,490	35,890	11,602	--	100	25,023	22,820	32,470
Southeast	30,006	36,160	38,470	12,347	--	640	20,829	49,050	50,420
All Others	--	--	--	--	18,200	230	--	--	--
Ohio	444,543	520,400	527,470	145,756	89,960	21,030	323,148	455,000	476,740

4. Consumer harvesting techniques for tree fruits, especially in view of the use of smaller trees more closely planted than was formerly the case.

5. Utilization of lighter or smaller orchard equipment in closer spaced plantings, especially the high concentrate sprayers for disease and insect control.

Areas of fruit production in Ohio appear to be shifting only slightly. According to Table 2, the Northeast district remains first in apple tree numbers and second in peach tree numbers. The North Central district remains first in peach tree numbers and second in apple tree numbers. Some significant comparisons are as follows:

1. Semi-dwarf apple tree numbers in the North Central district increased about three times from 1959 to 1968. During the same period in the Northeast district, they increased about six and a half times.

2. Standard apple tree numbers in the North Central district decreased approximately 19% from 1959 to 1968 and declined about 25% in the Northeast district during the same period.

TABLE 3.--Ohio Peach Tree Numbers by Variety.

	1968		1965		1959	
Variety	Rank	Number	Rank	Number	Rank	Number
Redhaven	1	63,272	1	71,330	3	56,340
Halehaven	2	40,297	2	52,910	2	82,290
Redskin	3	28,987	4	29,840	11	8,990
Elberta	4	21,974	3	41,420	1	88,910
Sunhaven	5	21,263	7	19,430	17	2,890
Richhaven	6	15,447	8	18,740		
Golden Jubilee	7	14,994	5	23,860	4	44,070
Shippers Late Red	8	11,633	6	23,610	6	30,540
Kalhaven	9	9,339	13	9,750	14	3,210
Erly-Red-Fre	10	9,048	9	15,790	7	19,610
Fairhaven	11	6,657	11	11,960	8	17,930
Belle of Georgia	12	5,074	12	10,220	9	12,450
J. H. Hale	13	4,912	10	13,610	5	32,340
Baby Gold	14	4,039	14	9,360		
Loring	15	3,522				
Early Elberta			15	7,650		
Rio-Oso-Gem			16	7,420	10	10,260
Amber Gem			17	7,280		
Washington			18	5,380		
Other		62,691		75,440		73,010
Total		323,148		455,000		476,740

3. Peach tree numbers in the North Central district declined about 40% from 1959 to 1968 and in the Northeast district about 27% during the same period.

4. Semi-dwarf apple tree numbers have increased markedly in all areas of the state since 1959, with an especially great increase in the Central district.

5. Peach tree numbers have increased since 1959 in these districts and counties: Northwest and West Central districts, Sandusky and Stark counties.

Any shift in fruit producing areas may have implications for needed research in specific phases of soil management and nutrition, as well as pest control practices, mechanization, and cultivar performance. The slight changes which have taken place in Ohio do not at present indicate an overwhelming need for specific research under different soil and climatic conditions than is already underway. The branches of the Ohio Agricultural Research and Development Center where fruit research is now in progress should provide very useful information for the immediate as well as the distant future.

Table 3 shows trends in plantings of peach cultivars in Ohio. The less hardy cultivars have declined most rapidly in tree numbers. Some newer cultivars, such as Washington, Richhaven, and Redskin, show a decline in tree numbers since 1965, probably because of undesirable tree or fruit characteristics. The only two cultivars showing an increase in tree numbers since 1965 are Sunhaven and Loring. There have been significant numbers of new peach cultivars planted during the past 5 years but their total tree numbers were still below the level for reporting individual cultivars in the 1968 survey.

This trend in peach cultivars indicates a continued need for evaluating all new cultivars under Ohio conditions before recommending them for commercial planting. A shift in commercial acreages of a given cultivar or group of cultivars implies a need for additional research in nutrition, fruit thinning, pruning, tree training, and harvesting techniques.

The never-ending changes taking place in the Ohio fruit industry are the products of research. At the same time, they indicate the need for increased research in new facets of production and marketing.

Fruit Crops Research--1969. Part II. Tree Fruits. Research Summary 36, Ohio Agricultural Research and Development Center, Wooster, Ohio. July 1969.

NUTRITIONAL RELATIONSHIPS IN YOUNG REDHAVEN PEACH TREES

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Peaches are known to be one of the more responsive tree fruit crops. Such grower practices as fertilization, irrigation or moisture control, and pruning have a significant influence on the productive characteristics of the tree. The continuing task for the horticultural scientist has been to gain a better understanding into these responses and how to control them.

In the field of peach nutrition, numerous experiments have been conducted over the years in an attempt to determine the correct amount and type of fertilizer which should be applied to produce the best growth, yield, and quality of fruit. Much excellent information has been obtained. However, since soil types vary widely from place to place, even in the same orchard, the results have tended to reflect these particular soil conditions and may or may not be applicable to other orchards except in a general way.

In order to refine grower fertilization practices, a method was needed whereby the amount of fertilizer absorbed by a tree, rather than the amount applied to the soil, could be related to its growth and production characteristics. Foliar analysis is the diagnostic technique which has best established this relationship.

PRESENT STATUS OF PEACH NUTRITION PROGRAM

Experiments by such investigators as Thayer (1919), Havis and Gourley (1937), Beattie and Judkins (1952), and Hill (1955) have done much to establish the general nutritional requirements for peaches in Ohio. Nitrogen, for example, is known to be one of the most needed elements. Yields can be seriously impaired and quality affected if annual applications are not made at the proper time and in the correct amounts. Mid-July foliar levels of 2.8 to 3.2 percent nitrogen are

Fig. 1.--Peach Nutrition Orchard at Horticultural Research Unit No. 1.

recommended for bearing trees in Ohio. Higher nitrogen levels than this for young non-bearing trees are not considered detrimental because of the additional growth which may be attained.

A clear-cut deficiency of phosphorus which would affect yield and quality has not been observed on any major tree fruit crop in Ohio, including peaches. Deficiencies of potassium, magnesium, manganese, and boron have been noted. The foliar analysis program has helped determine to what degree these elements are a problem in grower orchards.

With such background information available, it appeared most logical that the next step, as a means of refining the nutritional requirements of this important crop, was to seriously study the interrelationships of the required nutrients when the three principal fertilizer elements (nitrogen, phosphorus, and potassium) were applied in various combinations and concentrations.

A series of 128 uniform Redhaven peach trees were planted on a deep Wooster silt loam at Research Unit No. 1 in the fall of 1966. The experiment was designed so that the effects of individual applications of N, P, and K as well as all possible combinations could be studied. Treatments consisted of single tree plots. Four levels of these three nutrients were used in order to create as wide a range of nutrient concentrations within the trees and their leaves as possible. The trees have been maintained in sod except for an area around the trees approximately 3 feet square. This area was kept free from grass or weed growth by approved herbicides.

The first applications of fertilizer were made in April 1967 and consisted of 1/16, 1/8, 1/4, and 3/8 lb. of ammonium nitrate; 0, 1/2, 1, and 1 1/2 lb. of 20% superphosphate; and 0, 1/8, 1/4, and 3/8 lb. of potassium sulfate per tree. These rates have been, in turn, increased by this same increment each year of the experiment thus far--1967, 1968, and 1969. They will be modified in the future as necessary in order to obtain the desired levels of nutrients in the foliage.

RESULTS AND DISCUSSION

Results to date are preliminary and represent only a progress report on the establishment of the experiment and some relationships found in young, non-fruiting peach trees. The initial fruit crop will be harvested during the 1969 growing season.

Using trunk circumference as a measure of tree growth, no differences have been obtained thus far (Table 1). In light of available foliar analysis information, this is not unexpected since all levels of nitrogen, phosphorus, and potassium are presently well above any critical level (Table 2). As mentioned previously, nitrogen levels between 3.2 and 4.0% as found here would not be considered excessive for young non-bearing peach trees. However, this may not be true as the trees enter their productive years. Previous investigations have shown that fruit color and quality tend to be adversely affected when leaf nitrogen content is high.

Table 3 shows that the application of these fertilizer elements, in addition to changing the content of N, P, and K in the leaf tissue,

TABLE 1.--Trunk Circumference (cm.) of Redhaven Peach Trees in the Fall of 1966, 1967, and 1968.

Treatment	Years		
	1966 cm.	1967 cm.	1968 cm.
1/16 N	4.0	7.8	13.5
1/8 N	3.9	7.0	13.3
1/4 N	4.0	7.6	13.6
3/8 N	4.1	7.7	13.9
OP	4.1	7.7	13.4
1/2 P	4.0	8.0	14.0
1 P	3.9	7.4	13.6
1 1/2 P	4.1	7.0	13.2
OK	4.1	8.0	14.4*
1/8 K	3.9	7.4	13.5
1/4 K	3.9	7.3	13.1
3/8 K	4.1	7.4	13.4

*Significantly different at the .05 level of probability.

TABLE 2.--Nitrogen, Phosphorus, and Potassium Content of 1 and 2-Year-Old Redhaven Peach Trees.

Treatment	Years	
	1967	1968
	Percent Nitrogen	
1/16 N	3.35	3.05
1/8 N	3.46	3.37
1/4 N	3.60	3.70
3/8 N	3.62	3.82
	Percent Phosphorus	
OP	.20	.26
1/2 P	.20	.27
1 P	.22	.28
1 1/2 P	.21	.29
	Percent Potassium	
OK	2.34	2.75
1/8 K	2.60	2.73
1/4 K	2.50	2.91
3/8 K	2.57	3.14

has affected the uptake of calcium, manganese, magnesium, copper, and zinc. Manganese, copper, and zinc have all increased in concentration with increasing nitrogen. Manganese content has also increased with additional increments of phosphorus. The manganese content was found to be two to three times greater in leaf tissue sampled in 1968 compared to 1967. Calcium, copper, and magnesium, on the other hand, decreased in concentration with each additional increment of potassium applied.

In conclusion, it is expected that the effect of these nutrient relationships will become more intensified as the trees enter their bearing years. The effect of these nutrients will also be more meaningful when expressed in terms of yield and quality of fruit produced.

TABLE 3.--Nutrient Content of Mid-Shoot Halehaven Peach Leaves as Influenced by Soil Applications of Nitrogen, Phosphorus and Potassium, 1967-68.

	Year					
	1967			1968		
Treatment	Mn	Cu	Zn	Mn	Cu	Zn
	ppm	ppm	ppm	ppm	ppm	ppm
1/16 N	83	12	34	171	12	31
1/8 N	99	13	36	210	12	33
1/4 N	127	13	36	338	14	38
3/8 N	139	13	37	394	14	37
	Ca	Cu	Mg	Ca	Cu	Mg
	%	ppm	%	%	ppm	%
0 K	1.15	13	.38	1.70	14	.32
1/8 K	1.13	13	.36	1.27	12	.24
1/4 K	1.10	12	.38	1.22	14	.26
3/8 K	.97	12	.33	1.23	12	.25
	Mn			Mn		
	ppm			ppm		
0 P	101			222		
1/2 P	119			284		
1 P	102			293		
1 1/2 P	124			314		

The use of herbicides as a means of controlling or eliminating undesirable plant growth around trees in this experiment has proved very beneficial. In previous studies with peaches under sod as compared to cultivation (Hill, 1952), higher rates of nitrogen had to be applied to maintain similar yields and foliar levels. Results in the present experiment tend to show that, to date, adequate nitrogen levels have been maintained in the trees at the lower nitrogen application rates.

Because of the research program conducted in Ohio in recent years using foliar analysis, it was possible in 1964 to make this service available to growers. An intensive program in plant nutrition and fertilizer problems such as the one being conducted here is considered necessary to keep abreast of grower needs and provide answers to problems which have arisen as a result of the foliar analysis program.

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The State Is the Campus for Agricultural Research and Development

Ohio's major soil types and climatic conditions are represented at the Research Center's 12 locations. Thus, Center scientists can make field tests under conditions similar to those encountered by Ohio farmers.

Research is conducted by 13 departments on more than 6200 acres at Center headquarters in Wooster, ten branches, and The Ohio State University.

Center Headquarters, Wooster, Wayne County: 1953 acres

Eastern Ohio Resource Development Center, Caldwell, Noble County: 2053 acres

Jackson Branch, Jackson, Jackson County: 344 acres

Mahoning County Farm, Canfield: 275 acres

Muck Crops Branch, Willard, Huron County: 15 acres

North Central Branch, Vickery, Erie County: 335 acres

Northwestern Branch, Hoytville, Wood County: 247 acres

Southeastern Branch, Carpenter, Meigs County: 330 acres

Southern Branch, Ripley, Brown County: 275 acres

Vegetable Crops Branch, Marietta, Washington County: 20 acres

Western Branch, South Charleston, Clark County: 428 acres